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## POLITICAL SCIENCE

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A FAINT SHOWER SWEEPED ACROSS CHARLES DARWIN'S lush country garden, in the south of England, one summer morning in 1863, and when his wife brought him some white roses a few hours later, the indefatigable naturalist noted that the flowers were stained, tainted with yellow-tinged raindrops. Darwin put a drop of the "dirty water," as he called it, under his microscope, and there appeared numerous brown spherical bodies, each about one thousandth of an inch in diameter. He faithfully recorded his observation in a letter to the *Gardeners' Chronicle*, whose editors recalled that leaves found in a London garden had had similar yellow patches, containing grains of local fir pollen. The assumption was that pollen grains had been carried by the wind from nearby trees or plants and deposited on the raindrops. "It is quite astonishing," the *Chronicle* observed, "what a multitude of bodies are carried about by the wind in the form of dust."

Darwin's observation passed unnoticed into the archives of natural history until Ronald Reagan's first administration, when palynology, or the study of pollen, became the centerpiece of a search by the United States and its allies for a mysterious new Soviet chemical weapon.

In 1981 the United States accused the Soviet Union of violating international arms-control agreements by using a new chemical agent in Southeast Asia. According to reports from some of its victims, the agent could cause people to bleed to death internally, a symptom not associated with any known chemical weapon. Even more mysterious, samples of the agent, known as yellow rain, were found to consist largely of pollen grains.

In one of the strangest scientific quests in recent years,

some of the best of America's scientists joined scientists from Western allied countries in a two-year international investigation to try and find an explanation for the pollen's presence. Had the Soviets discovered a military use for the botanical male sex organ? Was pollen in fact an ingredient of the new weapon? Or had nature somehow added pollen to the agent residue—perhaps in the same way that it apparently had added pollen to the raindrops on Darwin's roses?

STORIES OF LETHAL CHEMICAL WEAPONS BEING USED by Communist forces in Laos and Kampuchea had come from refugees arriving in Thailand soon after American forces left Southeast Asia, in 1975. The reports sounded so wild, apparently exaggerated and sometimes spiced by superstitions, that no one took them very seriously. However, as the number of refugees increased—especially Hmong refugees from Laos to Thailand—so the number of reports of chemical warfare mounted. In 1979 the United States government decided to look more closely at the evidence. For the first time, American investigators collected leaves and bark dotted with yellow spots that, the refugees said, were samples of the chemical agent they called "yellow rain." Army chemists tested the spots—each one a few millimeters in diameter and weighing less than a postage stamp—for all known chemical agents, including riot-control gases and mustard and nerve gases, but found nothing. However, Army doctors who visited the refugee camps and listened patiently to the tales of illness and death said to be caused by the yellow rain be-

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came convinced, on the basis of the stories alone, that the Communists were using some kind of illegal, lethal chemical-warfare agents—including an agent that caused internal bleeding and sometimes death.

Soon after President Reagan took office, the government, in what appeared to be a major scientific breakthrough, announced that it had solved the mystery. In September of 1981 Secretary of State Alexander Haig charged that Communist forces had been using mycotoxins, or fungal poisons, in Southeast Asia. If the charge was true, this was the first time such toxins had been used for mass killing, and it represented a new and menacing dimension to the threat of chemical warfare.

Haig's evidence was described as only a leaf and stem and was said to have been plucked from a bush in Kampuchea at the site of a recent battle between the Vietnamese and the Khmer Rouge forces. The leaf was reported to contain traces of the mycotoxins known as trichothecenes. Haig's staff speculated that the Soviets must have been involved, because the Vietnamese, who are military clients of Moscow, were not sophisticated enough to make such a weapon on their own. Later the United States would formally charge the Soviets with supplying the poisons to the Vietnamese and with violations of both the 1925 Geneva Protocol banning the use, though not the production and stockpiling, of chemical and biological weapons and the 1972 Biological Weapons Convention, which prohibits even the manufacture and stockpiling of biological weapons.

In respect of these treaties Haig's charges were terribly grave. They came at a time when the world was about to witness a new outbreak of chemical-weapons use in the Persian Gulf war and when United States intelligence was secretly forecasting a rapid expansion in the number of countries possessing chemical weapons. Questions of Soviet compliance with past treaties and the ability of the United States to confirm that the Soviets are adhering to a treaty—the process known as “verification”—inevitably affect the attitudes of the Geneva arms-control negotiators and, later, of the senators voting on any new agreements. Whether or not the United States did catch the Soviets violating one of the oldest international arms-control treaties and whether or not the Soviets have been experimenting on a distant battlefield with a new class of chemical weapon deserve the most careful examination.

**T**HE TERM *YELLOW RAIN* FIRST APPEARED IN THE American press on August 20, 1979. Writing for *The Washington Post* from Loei province, in northern Thailand, Stanley Karnow described how a young Hmong tribesman, Vang Dua Chang, had become a victim of chemical warfare in Laos. Vang had fought under General Vang Pao, the Hmong chief whose guerrilla army, funded and trained by the Central Intelligence Agency, had tried unsuccessfully to prevent a Lao-Vietnamese Communist victory. After the Americans left Southeast Asia,

most of Vang Pao's army fled, but several thousand of his guerrillas continued to fight in the remote highlands. Vang said that early in 1978 two jet aircraft had flown over his village at 1,000 feet, spraying a yellow rain. More than a hundred villagers fell sick, including himself. “I had a headache and my eyes swelled up, as if there were sand in them.” Twenty to thirty people in the village experienced sustained bouts of diarrhea and vomiting, he said, and a few days later they died.

Though convenient as a journalistic label, the term *yellow rain* concealed extraordinary confusion among the Hmong over exactly what kind of weapon was being used against them. Mostly, refugees reported—and the U.S. government accepted—that the agent left behind yellow spots or powders. But the refugees also offered a host of other descriptions of the “medicine from the sky.” It could be in the form of a gas, rain, or smoke. It could be in bombs, artillery shells, mines, hand grenades, or sacks that burst in midair. And it could be red, brown, green, blue, gray, black, or white, as well as yellow.

The range of colors was bewildering to government analysts at the U.S. Army's Chemical Research and Development Center, at the Aberdeen Proving Grounds, in Maryland, and at the nearby Armed Forces Medical Intelligence Center, at Fort Detrick. Most known chemical agents are basically colorless when disseminated, and some analysts wondered whether the refugees could be confusing chemical weapons with the relatively innocuous colored-smoke bombs that are often used as target markers. Others wondered whether the Soviets could be using the remote battlefields in Southeast Asia to test a whole new arsenal of chemical agents.

Even more puzzling than the colors was the range of symptoms described by the victims. Many reported smelling something hot and peppery that produced a burning sensation in the eyes, nose, and throat, and they spoke of coughing, headaches, and vomiting—all symptoms of normally non-lethal riot-control gases commonly used by police forces. Such gases were used extensively by U.S. forces in Vietnam, and they are not considered by the United States to be subject to the restraints of the 1925 Geneva Protocol. But the refugees also reported more serious symptoms—the bloody diarrhea and vomiting of blood—that could result in death.

By the winter of 1979 the only persuasive evidence of chemical warfare was the sheer bulk of the refugee testimony, now totaling more than sixty reports. The first set of interviews was compiled by a State Department team. It relied largely on the part-time activities of two young foreign-service officers at the U.S. Embassy in Bangkok, Ed McWilliams, who had served in Army intelligence in Vietnam, and Tim Carney, who had served in the embassy in Phnom Penh before 1975, plus a regular Army officer who had been in the Special Forces in Vietnam, Lieutenant Colonel Dennison Lane. None of these men had any special training in chemical warfare or medicine; as even they concede, their efforts at gathering evidence were amateur.

Funds allotted to the task were sparse, and McWilliams, who made trips from Bangkok to the refugee camps, could afford only the overnight bus to Chiang Khan, a northern Thai town from which he would hitch a ride into Ban Vinai camp. Ban Vinai became the prime source of stories about yellow rain, a fact that those skeptical of yellow rain say is important, because Ban Vinai had been established as a special camp for the remnants of Vang Pao's guerrilla army. Although McWilliams and Carney were diligent and dedicated officers, they had little guidance from Washington as to how the interviews should be conducted.

The Washington professionals, moreover, took little notice of their reports. Yellow rain was one of those ill-defined, seemingly goal-less foreign-policy sideshows with no career points attached. Also, some of the stories clearly were based on Hmong folklore. Refugees told other tales of a tree that during battles acted like a giant magnet and attracted anything metal, from rifles and hand grenades to exploding shells. Although the most common sample produced by the refugees was yellow spots on leaves, stones, or bark, they handed in all kinds of things, many of which had nothing whatever to do with chemical warfare. A tangled mass of purple cobwebs was offered by one zealous collector. Samples of yellow rain became a kind of refugee currency, to be offered to the camp authorities in the hope of a better life somewhere down the road.

As for the samples themselves, the U.S. investigators never knew their precise origins. Sometimes refugees fording the Mekong River, which runs along the northern border between Laos and Thailand, would bring samples; at other times an anonymous caller to the Bangkok embassy would say that a sample was available, and a member of the U.S. team would meet the source in a café and collect the sample, which was usually wrapped in plastic or even contained in a paper bag. Asked where the sample came from, the source would typically reply, "Oh, my friend in the resistance gave it to me." "Resistance" meant Vang Pao's army. Sometimes samples were obtained by bartering bottles of brandy at Thai police stations near the Lao-tian frontier. The yellow spots on leaves and bark were sent back to the Army's Aberdeen laboratories, but all tested negative for any known chemical agents.

At first none of the analysts at the State Department could find any patterns or clues in the refugees' stories to indicate what the Communist forces might be using. A CIA analyst said later, "We did not fundamentally believe the [refugee] reports. We thought that riot-control agents, possibly some tear gas and some incapacitants [non-lethal agents that put enemy troops out of action for a few hours without causing them any long-term harm], were being used." But as the number of reports grew, a curious complaint was discovered. The victims' skin itched and sometimes burst into white, fluid-filled welts; other times it turned black, even in areas protected by clothing. The skin disorders prompted the U.S. Army to send a five-man medical team to Thailand in the fall of 1979, with a dermatologist, Colonel Charles Lewis, in charge. The team

spent a week interviewing about forty Hmong refugees and found that more than half of their reports mentioned symptoms that could not be attributed to any known agent. On the basis of refugee interviews alone, Lewis estimated that between 700 and 1,000 people had died—the estimate would reach more than 7,000 as the inquiry continued. Lewis also concluded from the symptoms described by the refugees that three different agents had been used: a non-lethal riot-control gas, a lethal nerve gas that produced muscular convulsions, and a totally unknown agent that produced the internal bleeding. Now U.S. intelligence had a set of guidelines to help in its future inquiries, plus a special mission to find the mysterious agent.



THE MONITORING OF SOVIET CHEMICAL AND BIOLOGICAL warfare activities was given a hefty boost after Ronald Reagan was elected in November of 1980. Officials in the new Administration sought information that could be used to show that the Soviets had cheated on past arms-control agreements, both nuclear and chemical, and the new director of the CIA, William Casey, upgraded the priority given to collecting information. In Bangkok, Ed McWilliams recalls, "increasing pressure came from Washington to identify the lethal gas."

At home, intelligence analysts started to follow a new trail. A toxicologist named Sharon Watson, who had studied fungal toxins before joining the Army's medical-intelligence unit at Fort Detrick, is credited with being the first to match the mysterious hemorrhaging described by the refugees with a distinctive, though not exclusive, symptom of trichothecene poisoning in animals and human beings: weakening of the capillary walls of blood vessels, sometimes resulting in internal bleeding.

A search for outbreaks of human fungal poisoning—from mycotoxins found naturally in moldy grain—took analysts back more than a millennium. Epidemics of what are now believed to have been mycotoxin poisoning are recorded throughout history. One of the last serious outbreaks occurred during the closing years of the Second World War, when thousands of peasants in the Orenburg district of the Soviet Union died from eating moldy grain. Later the epidemic was attributed specifically to the ingestion of trichothecene toxins. Watson speculated that

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the Soviets might have recognized the military potential of trichothecenes and turned them into a weapon—speculation that U.S. intelligence leaked to the media.

At the end of 1980 the CIA arranged for Sterling Seagrave, a peripatetic American journalist who was researching a book about chemical warfare, to meet Watson. In addition to the stories from Southeast Asia, Seagrave had heard reports of Soviet gas attacks against resistance fighters in Afghanistan and gruesome tales of lethal yellow and blue gases that made victims vomit blood and bleed from the eyes, nose, and ears. Seagrave's research in medical literature had suggested to him that some exotic marine toxins could cause similar symptoms, and he had approached the CIA with his theory. The CIA arranged for him to give a briefing to a group of yellow-rain investigators at the Defense Intelligence Agency. Watson was among them.

A few months later, on the condition that she not be identified as the source, Watson told Seagrave about her trichothecene theory. He was the first person outside the intelligence community to hear about it, and it became the focus of his book. "I've often pretended that I was the one to make the first [mycotoxin] connection, but that's only because I wasn't in a position to point the finger at Sharon," Seagrave now admits. "I was more than happy to take the credit."



AT FIRST WATSON'S SUPERIORS AT FORT DETRICK AND Aberdeen regarded her trichothecene theory as a little farfetched. They argued that the Soviets had much more effective agents already in their arsenal, so there was no reason for them to bother with trichothecenes—unless Southeast Asia battlegrounds were being used to test a new group of toxic weapons. Analysts at the CIA examined the files on Soviet toxin activity. Christopher (Kit) Green, a doctor working for the CIA who had been involved since 1976 in monitoring chemical-weapons use, "levied requirements," as the intelligence jargon goes. When analysts suspect something they cannot confirm and need classified information to pursue the suspicion, they ask government agencies monitoring the various intelligence-collection systems—satellite reconnaissance, intelligence from radio intercepts, and defector interrogations—for any relevant information. Green wanted to see

if the dates of attacks given by the refugees coincided with the dates provided by this other intelligence. His inquiries were secret, of course, as was the whole trichothecene mission, and to this day Green does not talk for the record about his work at the CIA. But in May, 1983, in a review of the government's inquiry, Green told relief workers at the Ban Vinai refugee camp that he had calculated early in 1981 that accidental correlations between the refugee stories and the intelligence information might be about 25 percent, and he had been astonished to find that the actual correlations were between 60 and 70 percent, a fact that added considerable credence to the refugees' testimony.

Still, scientific proof from sample evidence had not yet been found. In March of 1981 Thai military authorities delivered to the U.S. Embassy in Bangkok a sample of the alleged chemical agent made up of leaf and stem fragments. The fragments were said to have been taken from a battlefield in Kampuchea within twenty-four hours of a chemical attack. Watson was given the go-ahead to analyze the sample for trichothecenes. The Army laboratory was not equipped for such work—no one had ever considered trichothecenes a useful chemical-warfare agent—and a civilian analyst named Chester Mirocha, of the University of Minnesota, was employed as an outside consultant. During fifteen years of testing samples of corn for mycotoxins Mirocha had been doing analysis by a method known as gas chromatography-mass spectroscopy, or GC-MS. Today's GC-MS machines can cost in excess of quarter of a million dollars and can detect and identify the ingredients in a mixture down to billionths of a gram.

Mirocha's lab seemed like a good choice for an independent analysis—its distance from Washington helped establish a distance from government bias—but there was a problem in using Mirocha directly. He was theoretically prevented by university regulations from working on classified government projects, and the analysis of the yellow-rain sample was secret at that time. (The university's administrators later decided that Mirocha's work fell under the category of "outside services," and thus was not strictly university research, and the university regents commended Mirocha for his yellow-rain work.) Watson contacted her former associate Wallace Hayes, then a consultant pharmacologist with the U.S. chemical corporation Rohm and Haas. Hayes agreed to act as an intermediary between Watson and Mirocha so that Mirocha, for the time being, would not know that he was working for the government. Hayes took the Kampuchean sample to Mirocha's laboratory and asked him to analyze it for trichothecenes.

"I had no idea where the sample came from," Mirocha says, "and when Hayes said it was leaves, I asked him, Why leaves? Normally we analyze corn samples. He said he couldn't tell me. I thought he might have some new process for producing large quantities of trichothecenes and his company probably wanted to patent the process." Mirocha agreed to do the analysis. He says he didn't take it seriously until he started to find considerably larger amounts of trichothecenes than he would have expected in

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an average agricultural sample. Unaware of the significance of his findings, Mirocha reported to Hayes that the sample contained an unusual combination of three different trichothecenes, called nivalenol, deoxynivalenol (DON), and T-2, in concentrations of 109 parts per million (ppm) nivalenol, 59 ppm DON, and 3.17 ppm T-2. A person weighing 110 pounds would have to eat at least a pound of such leaves before they could be considered lethal. In a subsequent sample of yellow powder Mirocha found a fourth trichothecene called diacetoxyscirpenol (DAS). Mirocha would say later that in fifteen years of diagnosing samples he had found T-2 only ten to fifteen times, and then in concentrations about a thousand times lower than that found on the Kampuchean leaves. Mirocha's results convinced him and, later, Secretary of State Haig that something unnatural had happened.

In August of 1981 Sterling Seagrave learned of Mirocha's results from a CIA contact. Seagrave told his contact that he had already written the mycotoxin theory into his book and asked what the government planned to do with its new analyses. According to Seagrave, his CIA contact replied that any reaction was up to the government's interagency yellow-rain monitoring group, which would have to decide whether to go public with the evidence immediately or wait for further tests to be done.

The interagency group included representatives from the State and Defense departments, the CIA, the Defense Intelligence Agency, the Arms Control and Disarmament Agency (ACDA), the Office of Management and Budget, and the White House National Security Council. The group's ranking political appointee was Richard Burt, then the head of the State Department's Bureau of Political-Military Affairs, known as PM. Burt, a former journalist, had come to Haig's attention when Haig was the Allied Commander in Europe, through his aggressive reporting on national-security matters for *The New York Times*. Burt was also no newcomer to chemical warfare, having worked at the International Institute for Strategic Studies on NATO chemical-warfare options. Burt made no secret of the fact that his personal goal was to become assistant secretary of state for European affairs, and, in an Administration lacking foreign-policy expertise, he stood a good chance. But among the new Reagan hard-liners in the Administration and Congress, Burt—like Haig—was seen as a moderate, too pro-European and too soft on arms control. In presenting the government's yellow-rain case, however, this smart, ambitious man would demonstrate that both he and Haig could also be tough on the Soviets.

Some professionals were put off by Burt's brash style. They warned him against turning the yellow-rain issue into Cold War propaganda, fearing it could easily backfire. A thorough inquiry into the use of trichothecenes might be inconclusive; it might end with proof of nothing more than that the Soviet Union had been supplying riot gases to its Vietnamese clients. (The United States had itself used large quantities of riot gas in Vietnam.) Perhaps the government should wait for further scientific analyses before

making any announcement of the initial positive test.

Several forces worked to erode such institutional caution, however. Throughout the spring and summer of 1981 Jim Leach, a Republican congressman from Iowa, pestered and prodded the Administration to take more-direct action on yellow rain. As a foreign-service officer, Leach had spent two years on the U.S. delegation to the Geneva disarmament conference at which the 1972 Biological Weapons Convention had been drafted. He was thus somewhat more familiar with the highly technical and obscure world of chemical and biological weapons than his colleagues. He had been on a congressional visit to the refugee camps and had heard refugee testimony firsthand. His opinion was that lethal chemical weapons had been used, and he was conducting a personal crusade to publicize the issue. (Although most politicians in Congress would come to believe the government's charges, only a handful would actively take up the government's case, among them Republican Senator Larry Pressler and Democratic Congressman Stephen Solarz, now the chairman of the House Subcommittee on Asian and Pacific Affairs.) Leach, still fighting a lonely battle in 1981, would be very pleased with the outcome of the meeting of the interagency group which was called at the end of August to assess the implications of Mirocha's results.

**R**ICHARD BURT WAS IN THE CHAIR. THE GROUP HAD swelled that day to almost fifty—double the usual number. Several major questions were discussed: Was there enough information on which to base charges of a breach of international law? Was the science airtight? Would it be better to wait for further analyses? What would the intelligence agencies be giving away if they revealed their so-far secret conclusions? What effect would an announcement have on future arms-control talks?

Sharon Watson, who had been elevated into this politically charged setting by her trichothecene theory, insisted that there was a perfect fit between the symptoms of trichothecene poisoning and the mysterious symptoms described by the refugees. The concentrations found by Mirocha were said to be far higher than those occurring normally in any natural environment, and the three trichothecenes that had been found together were a combination unknown in nature, according to the government scientists. Moreover, Watson asserted, the scientific literature revealed nothing about a natural occurrence of trichothecenes in Southeast Asia; they were unknown in that region. However, they did occur in temperate regions, especially the Soviet Union, and Soviet scientific literature contained many studies of trichothecenes based on outbreaks of disease contracted by eating moldy grain. If anyone knew how to make trichothecenes in the quantities and strengths needed for weapons, the Soviets did.

Kit Green told the group that he had just returned from a field trip to Thailand, where he had seen reports on autopsies performed on alleged yellow-rain victims by the

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Thai military within twenty-four hours of an attack. Green would say later, "In one case bodies were examined, and crude field autopsies on approximately six or so soldiers were conducted, and the description was brought back of erosion in the stomach and the gastrointestinal tract, swelling of the spleen, that sort of thing." Green told the group that these symptoms were typical of the action of small-molecular-weight toxins, such as trichothecenes, and that the autopsies strongly suggested that toxins, possibly trichothecenes, had caused these deaths. Put together, the testimony of Watson and Green was "very persuasive," recalls one of the participants. "They never gave us any cause to have a reasonable doubt."

Despite Watson's confident assertions, Defense Department and intelligence officials remained undecided as to whether the government should make its findings public. Some feared that a public yellow-rain charge could rebound by arousing concern about a chemical-arms race and hindering the Reagan-backed proposals for a new generation of nerve-gas weapons. The intelligence agencies worried that they might disclose too much about their secret scientific detective work. The idea that the United States might have to reveal to the world how it had uncovered the Soviets' dirty work was "giving a lot of those guys out there [in the CIA] cardiac arrest," according to one member of the group. Both the CIA and the Defense Intelligence Agency urged delay.

The arms-control agency, ACDA, found itself in a special predicament. Under President Carter the United States had expressed concern about the refugee reports in private meetings with the Soviets and the Vietnamese; the Soviets had denied any wrongdoing, and bilateral talks on a new chemical-weapons treaty had continued until Reagan suspended them, in 1981. Some ACDA officials worried that the Soviets would be bound to react negatively to a public charge and thus delay meaningful negotiations toward a new chemical-weapons treaty. A second ACDA view countered that if there were grounds—any grounds—for supposing that the Soviets were indeed violating existing agreements, then the United States should say so. If that meant the end of arms-control talks, so be it. What was the point of negotiating treaties with people who didn't honor them? State Department professionals pushed for an announcement on humanitarian grounds, saying that it was the responsibility of the U.S. government to attempt to save lives by making public charges, even with slender evidence. Burt introduced the deciding factor. He said that the timing of an announcement had become crucial: publication of Sterling Seagrave's book containing the trichothecene theory and of a *Time* magazine story was imminent, and the State Department could not allow an outside source to be first with the news. Burt argued that if the government were scooped by the book and the magazine (which had been alerted to the test results by Seagrave), the State Department would look bad. "Burt seemed somewhat obsessed by being scooped," one participant later observed. "If he hadn't been a journalist before being

a politician, I doubt if he would have been so concerned about Seagrave and *Time*."

Burt advised the meeting that a good opportunity for announcing the results would be Haig's upcoming trip to Berlin. The charges would bolster the theme of Haig's speech, which was aimed at countering criticism of Western defense plans, especially the scheduled introduction of cruise and Pershing missiles into Europe. Burt just "railroaded it through," a participant recalled. "We were left with no doubt that Haig was going to do it."



AT FIRST HAIG'S YELLOW-RAIN SPEECH, GIVEN TO THE Berlin Press Association on September 13, seemed like a propaganda triumph. The next day the charges were widely reported and little questioned—at least in the American press. Some scientists criticized the paucity of the evidence, but the next month Mirocha reported finding trichothecenes in three more environmental samples. Burt quickly emerged as the Administration's chief yellow-rain spokesman, telling a congressional committee in November, "We now have that smoking gun." Using vivid descriptive prose better suited to his old newspaper columns than to Senate testimony, Burt described the "bright red blood" vomited by the yellow-rain victims and the sound of yellow-rain particles falling on rooftops. He reported that the collector of one water sample from Laos had accidentally spilled it on his person while bringing the sample through the jungles to Thailand. "As I understand it, he actually arrived in Thailand gravely ill . . . and contracted some of the symptoms that are connected with these mycotoxins," Burt said.

In the hearing room was Matthew Meselson, a veteran witness of congressional inquiries into chemical and biological warfare, who had also been invited to testify. Meselson is a Harvard biochemist whose laboratory is one of the nation's centers of research into molecular genetics and recombinant DNA. His early work on the double helix, colleagues say, could easily have brought him a Nobel Prize. Regarded as brilliant on both technical and theoretical questions, and as possessing inexhaustible patience, he was among the best and the brightest who flocked to Washington to work for the Kennedy Administration. He evaluated biological weapons at ACDA, was dismayed to find that

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the United States was stockpiling such weapons, and began a long campaign to eliminate them from the arsenals.

Skeptical of Burt's testimony, Meselson made a quick calculation to see if the collector of the water sample could have become ill so quickly. Mirocha reported that the sample contained sixty-six parts per million of the trichothecene known as DON. Meselson estimated that if the trichothecenes were in solution, a person of average weight would need to swallow several quarts of the liquid for it to kill him. Later Mirocha revealed that he had analyzed not the solution itself but the thirty-three-milligram fragment of debris that remained after he'd evaporated the solution. The dried fragment had contained the DON, and the concentration of it in the solution as a whole was actually 0.22 ppm, not sixty-six. A person of average weight would have had to drink over 500 gallons of the solution at that concentration before he became "gravely ill."

That particular incident apart, the government's overall presentation of the case made Meselson suspicious. Although he agreed that the preliminary evidence could indicate that mycotoxins had been used on the battlefield, he was not satisfied with three of the government's points. First was the assertion that trichothecene mycotoxins, which are produced by fungi in the genus *Fusarium*, are common to cereal crops in cold climates but unknown in Southeast Asia. Meselson said that there simply was not enough known about trichothecenes to say that. Laboratory tests had shown that of the four trichothecenes reported by Mirocha, *Fusarium* produces all but T-2 in substantial concentrations even under very warm conditions.

Second, Meselson doubted that trichothecenes disseminated in particles or droplets, as described by Burt, would cause rapid hemorrhaging and death. In his own literature search Meselson had found studies suggesting that doses of T-2 taken orally by animals had no such effect. He noted that a recent paper co-authored by Mirocha and titled "The Failure of Purified T-2 Mycotoxin to Produce Hemorrhaging in Dairy Cattle" supported this suggestion, as did a British report that found similar negative results in calves and pigs. "This is not to say that under some as yet undemonstrated conditions some of the reported trichothecenes, singly or in combination, cannot cause the reported symptoms," Meselson said in his testimony at the hearing. "The point is . . . that at this time it would not be correct to say, regarding the demonstrated symptoms of the four trichothecenes and the reported symptoms, that the fit was perfect."

Third, Meselson introduced a new area of doubt concerning the type of chemical agent that might have been used. He showed that the symptoms reported by the refugees from Laos and Kampuchea were similar to those reported by Vietnamese highland villagers who had been close to areas sprayed with herbicides by the U.S. Air Force. "Now, we believe that the herbicides used should not have had these effects unless the villagers had some unusual and quite unexpected sensitivity," Meselson said. "However, this experience [in Vietnam] tells us that be-

tween the reported perceptions of the interviewed villagers who were exposed to herbicide spraying and the perceptions of the officials in Washington who authorized the herbicide program there was an extraordinary discrepancy. In sifting the various possible explanations of what occurred in Laos and Kampuchea, it may be important to keep this experience in mind. In summary, I would agree that our main interest is to stop what appears to be a serious use of toxic chemicals, [but] a convincing case has yet to be made to the scientific community that trichothecenes are in use. The question of their natural occurrence, I would say, is still at issue, and questions regarding the match of symptoms are also unresolved. And although problems of confidentiality may arise here, we need full and reliable assurance of the authenticity of the samples. While we keep studying and accumulating more data and . . . while we put the detailed findings before the scientific community, as has not yet been done, we should not hinge our efforts on the unqualified assertion that trichothecene toxins must be responsible for reports of chemical attacks in Laos and Kampuchea."

**D**URING THE YEAR FOLLOWING HAIG'S CHARGES against the Soviets the United States bolstered its evidence with samples of blood and urine taken from Khmer Rouge soldiers who said they had been attacked with chemical weapons. Mirocha reported finding trichothecenes, although only traces, in these samples. A second independent analyst, Joseph Rosen, a food scientist at Rutgers University, reported another positive test on a sample of yellow powder, said to have been scraped off foliage inside Laos in May of 1981 by a Hmong resistance team. The sample was given to an American, Charles Whitney, then a hospital administrator at Ban Vinai camp. He brought the sample back to the United States and gave it to an ABC-TV documentary team, which asked Rosen to analyze it. Rosen reported that the yellow sample contained a combination of the three toxic trichothecenes DON, DAS, and T-2, in concentrations of roughly 50 ppm each. He also reported, for the first time, the presence of a man-made substance called polyethylene glycol, or PEG, a common soapy compound, which, Rosen suggested, could have been a dispersant for the poisons. The ABC film highlighted the PEG discovery as evidence against a natural origin for the poisons.

By the end of 1982 the State Department claimed that its evidence of trichothecene use in Southeast Asia was conclusive. And, for the first time, the government said it had physical evidence of the use of trichothecenes in Afghanistan. Adding unexpected drama to a State Department press conference on yellow rain in November of that year, U.S. officials unveiled a small plastic cabinet containing a Soviet gas mask from Afghanistan. As photographers snapped pictures of the mask, Robert Dean, the deputy director of the Bureau of Political-Military Affairs, said that positive tests reported by three labs—including Mirocha's

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and the Army lab at Aberdeen—on two Soviet gas masks were “conclusive” evidence that the Soviets had been using trichothecenes in Afghanistan.

Such was the force of the official assertions that the American media, without further inquiry, immediately sounded more convinced than before of the validity of the government's charges. *The Washington Post*, which had been lukewarm on the evidence, said, “It seems to us now, however, that the administration has proven out the Soviet pattern by a standard that reasonable people would accept.” *The New York Times*, which had been and would remain more skeptical than most newspapers, declared, “If the case is still inconclusive, it is stronger. It cannot be shrugged off by the Russians.” The government's most faithful media ally in the yellow-rain saga, *The Wall Street Journal*, said that the implication for arms control was clear. “If you accept the fact of yellow rain [which *The Journal* had always done], it seems to us, you have to ask whether we have anything to talk to these people about.”

Matthew Meselson, on the academic sidelines, had been watching with deepening concern as the government's allegations provided those in the Administration who opposed arms-control treaties with increasingly good reasons for refusing even to try to negotiate such pacts with Moscow. Also, the United States had arrived at a crossroads in deciding what to do with its own arsenal of chemical weapons: the new Reagan defense team wanted to apply their peace-through-strength policy to chemical weapons by pushing ahead with the production of a new generation of nerve-gas weapons. At the end of the Carter Administration, Meselson, in a report to the government, had argued against such a move, saying there was no pressing need for the new weapons to give the United States a means to retaliate against—and thus to deter—a chemical attack. Instead, the present chemical stockpile should be maintained and upgraded. Reagan officials paid no heed.



AS MESELSON LOOKED MORE CLOSELY AT THE GOVERNMENT's scientific evidence, and as more of it accumulated, he became increasingly skeptical. The number of samples reported to be positive for trichothecenes was tiny compared with the number of samples collected. By the end of November, 1982, out of more than

350 samples that were, as the State Department put it, “of greatly varying types and utility for analytical purposes,” only six environmental samples—five analyzed by Mirocha and one by Rosen—plus sixteen blood and urine samples had been reported positive. An overwhelming number showed no signs of trichothecenes. There was also a dispute over the government's assertion that the concentrations and combinations of trichothecenes reported by Mirocha's laboratory were unnatural. Scientific studies indicated that both the concentrations and the combinations might be found naturally. The study of mycotoxins was still a young, rapidly evolving science. A cautious scientist might consider it hazardous to make any definitive statements about the natural occurrence of mycotoxins.

In fact, as fast as the government's new evidence emerged, its significance as material scientific proof of the use of trichothecenes faded. The Afghanistan gas masks were billed as major discoveries, and they were the first pieces of military equipment from any battle area, including Southeast Asia, to contain trichothecenes. However, one of the masks was quietly dropped as material evidence. It was said to have been taken from a dead Soviet soldier in Afghanistan, but tests were not conclusive, only “indicative of the presence of trichothecenes”—a result that carried little weight among government investigators. As for the second mask, there was no evidence that it had ever been used in battle. It was said to have been bought in Kabul in a “special operation,” and only the outside of the mask was contaminated. If it had been worn in combat, as the State Department had suggested, the filter should have been contaminated too. No one could be sure that it had not been lying in a sack of moldy corn, or been otherwise contaminated, before it was obtained.

Similar doubts and uncertainties surrounded the post-mortem of a Khmer Rouge soldier named Chan Mann, who, the State Department reported, had been caught in a toxic-chemical attack by Vietnamese artillery on February 13, 1982, near the village of Tuol Chrey, on the Thai-Kampuchean border. A month later Chan suddenly became feverish, restless, and slightly jaundiced. He lapsed into a coma and died. According to the State Department, Khmer Rouge doctors, assisted by Dr. Gary Humphreys, of Canada's Department of National Defense, performed an autopsy. Tissue samples were sent to Chester Mirocha, who found T-2 (in parts per billion as opposed to parts per million) in Chan's stomach and intestine, and a metabolite, or secondary product, HT-2, in his heart, stomach, and intestine. Joe Rosen also found T-2, but not HT-2, in Chan's body tissues. However, Canadian scientists who analyzed Chan's tissues found no trichothecenes. In fact, the Canadians could not even agree that Chan had died of trichothecene poisoning. They attributed his sudden death to acute kidney failure and terminal waterlogging of the lungs—symptoms consistent with a severe attack of *Falciparum* malaria, commonly known as blackwater fever.

Among these unsatisfactory and inconclusive pieces of

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evidence was one intriguing fact, which the State Department made public, almost as an aside, at the November, 1982, press conference. The environmental samples of yellow material from Southeast Asia contained pollen. Four other countries—Australia, Britain, Canada, and Thailand—had found pollen and had informed U.S. investigators as early as January of 1982. The American analysts had missed pollen altogether in their analyses.

The presence of pollen had great potential—for either supporting or undermining the government's case. If the pollen came from local trees or plants, this would suggest a local, natural origin for the yellow spots offered by the refugees. If it was from vegetation exclusive to the Soviet Union, then the United States had vital evidence fitting Haig's original charges.

Aberdeen had no resident pollen experts—or palynologists, as they are called—and Joan Nowicke, a palynologist at the Smithsonian Institution, in Washington, was asked to help. She spends a lot of her time painstakingly identifying and cataloguing grains of pollen from the quarter of a million types of flowering plants that exist worldwide. One day in October of 1982 the quiet, almost monastic, work life in Nowicke's laboratory was disrupted by the arrival of three government yellow-rain investigators. They brought photographs of pollen grains from samples of yellow rain from Southeast Asia and asked Nowicke to identify them. She told them that nothing in palynology happened that fast. She recalls, "I had to explain to them how long it takes to make identifications, particularly as they were hoping that the pollen would be distinctive enough that it could be easily identified as belonging to a plant very narrowly distributed—in Leningrad, for example." But the investigators were out of luck: the pollen they showed Nowicke was from daisies and grasses. "Plants you find all over the world," Nowicke told them. The identification of other pollen types might take time, she advised—perhaps as long as six months.

But the government decided not to wait. Its investigators were already confident that they understood. The yellow pollen matched the yellow color of the new chemical weapon described by the refugees, and the government suggested that the pollen could act as the carrier for the trichothecenes. After the sticky poisonous rain hit the ground, so the theory went, it dried and could be inhaled. The size of the pollen grains—between ten and twenty microns in diameter—was claimed to be the right size for retention in the lung tissue. "It's a very clever mixture," Sharon Watson told reporters. No one asked the obvious question: Where did the pollen come from? Instead, Gary Crocker, a State Department intelligence analyst, volunteered that the pollen was of a type that "would be commercially collected by insects, the type of thing a honeybee would take from flowers." Crocker's assertions were made with such confidence that no one even asked why the Soviets would use pollen as a carrier or, indeed, how the huge amounts of pollen needed might have been collected.

MATTHEW MESELSON AND A BRITISH COLLEAGUE, Julian Perry Robinson, were fascinated by the presence of pollen, however. Robinson is Britain's leading independent chemical-warfare expert, deceptively shy and retiring compared with the animated Meselson, but highly regarded in academic and government circles on both sides of the Atlantic.

Alerted by the government to the presence of pollen in "most of the samples," Meselson and Robinson, as Darwin would surely have done, began to look for a possible natural explanation for the presence of pollen. Could the tiny yellow spots have formed on the leaves by a natural process? they asked. Pollen is distributed in two ways—by winds and thermal currents and by insects, primarily bees. Gary Crocker had said that the pollen in the yellow-rain spots was not of the windborne variety but rather of the type that a honeybee would take from flowers. Was he correct? Could bees make tiny yellow spots on leaves?

In the spring of 1983 Meselson helped to organize the first conference on yellow rain, at the American Academy of Arts and Sciences, in Cambridge, Massachusetts. Thirty-four persons attended, among them some of the key players on both sides of the yellow-rain affair. It was the first time the opposing sides had met for a round-table discussion. There was no contemporaneous report of the meeting in the media, because Meselson had insisted that the conference be closed to the press so that the participants could speak freely. The transcript, which I obtained later, runs to 166 pages of single-spaced type.

The first step to unlocking the pollen mystery came at this conference from a Harvard botanist, Peter Ashton, a genial Englishman with a colonial air who had lived in the Far East for fifteen years before coming to Harvard and who was an expert on tropical flora. In a sample of yellow-rain spots analyzed by the Australians, Ashton had noted that the pollen grains were too highly concentrated to have been windborne and that the pollen came from grasses and weeds, and from trees and shrubs common to Indochina. The pollen of all these plants is collected by bees—but Ashton could not explain how the bees turned the pollen into little yellow spots that stuck to leaves and pebbles. Perhaps they ate pollen and regurgitated it, he suggested to his colleagues. To be sure, it seemed farfetched, even ridiculous, but *could* the yellow-rain drops that Hmong refugees and others said were chemical agents be the vomit of bees?

Later Ashton described the yellow spots to Tom Seeley, a bee expert from Yale, who immediately replied, "I don't think the State Department's interpretation of these yellow spots is the most parsimonious one. This sounds to me like bee cleansing flights"—communal excursions during which tens of thousands of bees fly at a height of about fifty feet and defecate tiny yellow spots, each containing hundreds of thousands of digested pollen grains. Seeley explained that when he used to keep beehives on the roof of the Museum of Comparative Zoology at Harvard, the

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staff members who kept their cars in the parking lot complained about the little yellow spots that appeared on their vehicles. Each spring, when it was warm enough, the worker bees emerged from hibernation with their guts full of the indigestible husks of pollen grains—sometimes up to a dozen different pollen types, because one hive's pollen store contains the results of weeks of forages all thrown together. Seeley did not know, however, whether bees go on cleansing flights in the tropics, where the narrower temperature ranges mean that bees don't hibernate, as their northern relatives do. (That question would eventually be answered by an expedition to Thailand, during which Meselson and Seeley were rained on by honeybees on a cleansing flight.)

In the meantime Meselson busied himself by scraping some bee feces from windshields in the parking lot beside his Harvard laboratory. He found that they contained up to eight different types of pollen grains, plus bee hairs and the wispy filaments of fungus spores. Excited by the new hypothesis, Meselson took these samples and the yellow-rain samples he had now collected from the Australians, the Canadians, and Rosen to Joan Nowicke for pollen identification. She had never heard of bee cleansing flights, so Meselson invited her to take a look at the Smithsonian parking lot—where they found at least fifty yellow spots of bee feces on Nowicke's car. She agreed to help.

**T**HE BEE THEORY OF YELLOW RAIN WAS OFFICIALLY unveiled by Meselson and Seeley on May 31, 1983, at the annual meeting of the American Association for the Advancement of Science, in Detroit.

Meselson and Seeley showed two sets of photographs of pollen grains—from an alleged sample of yellow rain collected in Thailand and from bee feces found on a choke-cherry leaf in Massachusetts. The similarity was startling. Next they pointed out that of the six environmental samples from Southeast Asia (including Rosen's ABC-TV sample) reported to contain high levels of trichothecenes, three had been examined for pollen—and in each case pollen had been found. Of six additional samples of yellow deposits said to be the chemical agent—four examined by the Australian defense department and two by United Nations investigators—all contained pollen. Thus, whenever analysts had looked for pollen in yellow-rain samples, including those that were reported to contain trichothecenes, they had found it. And not just traces; the samples were all made up largely of pollen.

In the coming months Meselson would add more important evidence confirming that the spots were bee droppings. And, at the Smithsonian, Nowicke found that honey collected in Thailand contained the same types of pollen as the alleged samples of yellow rain. Also, the pollen found in yellow-rain samples was hollow, indicating that bees had digested the protein and excreted the indigestible pollen husks.

In short, Meselson and his colleagues had proved that

the yellow material handed in by the refugees was in fact bee feces.

Even though Meselson, Seeley, and Nowicke had not produced evidence of the natural occurrence of trichothecenes to explain Mirocha's findings, they had embarrassed the government with their exemplary inquiry. By way of a reply, State Department officials sought to ridicule the work of these meddlesome academics, dismissing it as "The Great Bee Caper." At a press conference in Washington on June 1, 1983, Alan Romberg, the State Department's deputy spokesman, explained where he considered that Meselson's inquiry had erred.

One of the positive yellow-rain powder samples, from Laos, had weighed 300 milligrams. This was "certainly more than a bee could drop," Romberg said. And, even if the sample had been bee feces, the bee would have died before excreting it, because the trichothecenes it contained would have been fatal.

To the layperson this rebuttal might have sounded conclusive, but, as the State Department's own evidence showed, the 300-milligram sample had never been a single yellow spot. The yellow substance had fallen to earth "like an insect spray," according to the refugee who had witnessed the alleged attack in Laos in March of 1981. The material did not fall to earth in a lump. The spray had dried to a powder and villagers had managed to scrape some of it off a rock and carry it through the jungle to Thailand. Also, Meselson had never suggested that bee feces still inside the gut of a bee would contain trichothecenes; he had said quite clearly that if the yellow spots were indeed the source of the poisons, as the refugees said they were, and the reported amounts of the poisons in the yellow feces were correct, the poisons would somehow have had to have been added, either naturally or by the intervention of man, after the bee had defecated.

The British magazine *Nature* commented in an editorial, "In presenting his theory last week, Meselson went through the exercise of listing where the evidence supports his theory and where it contradicts it. The State Department seems not to have taken the hint; nor did it admit that it should define the areas where questions remain. . . . To judge from what State Department spokesmen have been saying, Meselson's hypothesis is regarded as a threat, not as a legitimate question."

If Meselson was a threat, it was not because he might prove that trichothecenes could be found naturally in bee feces. Rather, Meselson was threatening because he was applying standards of scientific evidence that the government had never adopted.

In October, Stuart Schwartzstein, an ex-foreign-service officer then running a chemical-weapons project at the Institute for Foreign Policy Analysis, organized a round-table discussion of problems of collecting and analyzing the yellow-rain evidence. Present were Meselson, Rosen, and Mirocha. Mirocha had not seen Meselson since the congressional hearings in November, 1981, and he had been openly critical of the bee theory, calling it "ridiculous and

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even absurd." Schwartzstein took the three professors to dinner. "I might as well not have been there," Schwartzstein said later. "Meselson was so busy cross-examining the other two about their positive trichothecene findings, I never had a chance to say anything." In this conversation and in a subsequent discussion with Emery Sarver, the chief of the Army's methodology research branch at Aberdeen, Meselson learned that Sarver had analyzed sixty environmental samples from alleged attack sites in Southeast Asia and had found no trichothecenes in any of them—even though Sarver's laboratory had used a GC-MS, the same kind of machine that Mirocha used, and even though the detection limit of the machine should have allowed Sarver to identify trichothecenes in concentrations 1,000 times lower than the average concentrations reported by Mirocha.

Sarver's samples had included ten of yellow powder, ten of water, and forty of foliage, some of which had contained yellow spots or powder. One of these samples—the now famous 300-milligram sample of yellow powder mentioned by Alan Romberg—had been tested by both Mirocha and Sarver, Meselson learned. In October, 1981, Mirocha reported finding 143 ppm of T-2 and 27 ppm of DAS. He did not look for pollen. A year later Sarver tested a portion of the same sample. He looked for pollen and found it, but he found no trichothecenes at all. Mirocha said later, "I really can't speak for the handling of samples in Dr. Sarver's laboratory. Our methods of extraction are based on fifteen years' experience. I can't expect Dr. Sarver just to go in there and conquer all the analytical problems. His area of expertise had been some of the nerve gases and they [the Aberdeen staff] are very good at things like that. This is all new to them."

"For me this was the turning point of the whole inquiry," Meselson said later. "It finally convinced me that the government did not really have a case to answer." On October 19, 1983, Meselson wrote a letter to Mirocha and Rosen setting out his findings and asking, "Why does Sarver find no positives out of about 60 samples from Southeast Asia and Mirocha plus Rosen find six out of six? In particular, why does Sarver find no T-2 and Mirocha find 143 ppm of T-2 in aliquots of the same sample? The apparent difference corresponds to a factor of more than one thousand between what Mirocha reports and what Sarver presumably could have detected. Is this a false negative, a false positive, or are both labs right?"

This is the scientist's way of asking whether Sarver's analytical procedures had failed to produce the right answer (a false negative) because he had used the wrong methods of analysis, or whether Mirocha's and Rosen's laboratories might have been contaminated with trichothecenes (a false positive), or whether some entirely different compound had mimicked the chemical signature of T-2 in Mirocha's and Rosen's laboratories but not in Sarver's (another false positive). "This all seems quite baffling," Meselson wrote. "What do you make of it and what do you think should be done?"

OF COURSE, MESELSON WAS SPEAKING OF THE ENVIRONMENTAL samples, and the government still claimed that it had further, and equally important, evidence of trichothecene poisoning from the samples of blood and urine. In January, 1984, the weekly magazine *Chemical and Engineering News*, published by the American Chemical Society, ran a thorough twenty-seven-page article by Lois Ember, a staff reporter, criticizing the scientific basis of the government's case. For the first time—and, it should be noted, not in the popular media—the inconsistencies in the government's laboratory results which Meselson had found received an airing. Ember also looked at the government's results from the samples of blood and urine, and she discovered that of sixty samples analyzed, twenty had been reported to contain traces of trichothecenes, but, again, Mirocha was the only analyst to find the poisons. Two of his twenty positives had been designated tentative findings because he had not had enough material to run a full analysis. The significance of the eighteen other positives was placed in doubt by the State Department's own early qualifications regarding the biomedical tests: "Little is known concerning the rate of metabolism of trichothecenes in humans. . . . T-2 is rapidly cleared from the blood in animals, and 25 per cent of the total dose is excreted within 24 hours after exposure; it is unlikely that trichothecenes could be detected unless blood samples were obtained within 24–48 hours after an attack." Yet positive samples had been collected from one to ten weeks after what were alleged to be attacks. The government now claims that its most recent studies show that T-2 can be stored in human beings in a tissue reservoir that releases the poisons over a longer period, perhaps weeks. However, these experiments are not conclusive, and they have not been released to the public for independent examination.

In February of 1984 the government reported to the United Nations that the use of trichothecenes had eased and that although "toxic-weapon attacks, deaths, and incapacitation" continued to be reported, there appeared to have been a "diminution of attacks in Afghanistan and a decrease in the lethality of attacks in Laos and Kampuchea." The government claimed success: the Soviets, officials argued, had been shamed by the yellow-rain publicity into ending violations of international law.

But skeptics had already identified in the government's inquiry a continual use of untenable assertions, tendentious logic, omissions, inconsistencies, and flawed methodology. And a few of them did not hesitate to make harsh judgment.

Nicholas Wade, an editorial writer for *The New York Times*, followed Ember's article with a signed editorial calling the government's science "shoddy." "Every eighth-grader can profit from study of the Government's case," he wrote. "It's a trove of erroneous scientific reasoning. . . . Science is founded on careful observation. Aristotle said men had more teeth than women, but he didn't look. The U.S. government bellowed that yellow rain was a toxin,

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sure proof of Soviet perfidy, but didn't look to see what else yellow rain might contain."

Wade listed the basic rules of scientific inquiry that had been broken: A difficult test or measurement must be repeated by a second scientist, just in case the first did it wrong—a reference to the failure to duplicate Mirocha's positive results. Science is cumulative; to ignore what's on the record is to build on air—a reference to the government's repeated and, as it turned out, erroneous claim that trichothecenes could not be found in Southeast Asia. Controls must be properly matched or conclusions are invalid—when skeptics suggested that the positive blood and urine samples could indicate that the "victims" had eaten moldy food, the government retorted that its "control" samples, taken at the same time from people who had not been exposed, were negative. But the government had failed to verify that the people from whom the controls were taken were eating the same food as the victims, thus voiding the comparison. The CIA was so concerned about Wade's criticism that it sent a delegation to the *Times* to argue the government's case, but to no avail. Among American newspapers the *Times* remained the toughest critic of the government's case.

In fact, not only the scientific evidence but also some of the key supporting evidence from intelligence sources is troublesome. For example, despite the confidence with which the charges were made against the Soviets, the U.S. government has been unable to produce a single munition or shell fragment contaminated with trichothecenes. And when Sharon Watson reported her original diagnosis of yellow rain as trichothecene poisoning, she included as evidence a 668-page Second World War intelligence report of interrogations of Soviet prisoners of war by a German chemical warfare expert named Walter Hirsch. According to Hirsch, the prisoners had described a powdery "yellow-brown" agent under development by the Soviet army. The prisoners called the agent *lebeda*, which the Hirsch report referred to as "a millet-like plant which in hard times is mixed with breadstuff. The bread made from it is often harmful and develops [sic] symptoms of poisoning." A 1983 CIA Special National Intelligence Estimate on yellow rain commented that this was "an indirect reference no doubt to the trichothecene contaminated millet that caused the devastating outbreaks in Orenburg." Yet Hirsch was never that definite about the specific properties of *lebeda*.

In his report Hirsch noted that "careful investigations showed that it was possible to interpret these bits of information [from the Soviet prisoners] in different ways" and that some of the symptoms of *lebeda* mentioned could be caused by extant chemical agents, particularly phosgene oxime, also known as "nettle gas" (which also causes many of the symptoms mentioned by the refugees). Hirsch said that a "plausible hypothesis" was that *lebeda* was a Soviet code designation for phosgene oxime. "More accurate information was not obtainable," he concluded.

THE GOVERNMENT, BY AND LARGE, GOT AWAY WITH its "shoddy" evidence for several reasons. For one thing, history has taught us, painfully and shamefully, the severe penalties for ignoring what at first appear to be exaggerated reports of mass human suffering. Most Americans were ready to believe the refugee reports; they were also inclined to believe that the Soviets are not only capable of using but also likely to use hideous chemical weapons. Such a receptive audience accepted standards of evidence lower than were required by the minority willing to examine the doubts that had been raised.

It should be noted that the Soviets did not endear themselves to this minority by offering a farfetched theory that the presence of trichothecene toxins in Southeast Asia was the result of U.S. policies in Vietnam. According to this theory, the Americans had artificially seeded elephant grass in areas deforested by their use of herbicides and napalm during the war. The grass created new breeding grounds for toxin-producing *Fusarium*, and the prevailing winds carried clouds of spores into Kampuchea and Laos. No one in the West took the theory seriously. "Science fiction," scoffed Paul Nelson, a plant pathologist at Pennsylvania State University.

Another reason for the success of the government's case was imbedded in the technical complexity of the science relevant to trichothecenes—even in the name itself. Which popular newspaper or television station would have considered devoting space or time to the following nugget of official scientific jabberwocky? One effect of trichothecene poisoning known to persist for several weeks after exposure is a depressed white-cell count in the blood. In a January, 1982, press release the State Department reported that a "trend" toward depressed white-cell counts had been observed in alleged victims of a chemical attack in Kampuchea. Two sentences further on the release said: "However, sampling size was so limited that there was no real statistical difference between control and exposed groups." This last sentence automatically voids the trend mentioned previously. Nevertheless, the government again mentioned the trend in a special yellow-rain report two months later, thus leaving the erroneous impression that there was indeed something odd about the white-cell count of alleged victims of yellow rain.

The Administration is justified in claiming a measure of success for its own political strategy, even a propaganda coup. Since Secretary of State Haig's speech newspapers across the country have carried scores of banner headlines and leading articles basically in support of the government's case. But the Administration has also succeeded in embarrassing itself and American science. The level at which the charges were made—up to and including the President himself—blocked any respectable avenue of retreat once the government's science was found to be faulty. America's allies, especially its closest ally, Britain, have known for some time that the United States simply did not have the scientific evidence to back up its charges. Government scientists in these allied countries have witnessed

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the United States bend the rules of scientific investigation to its own political advantage, in a manner that can only harm the credibility of future charges of treaty violations against the Soviets.

And what is one to make of Mirocha's analysis of environmental samples? It is, indeed, an oddity, because the government's own scientists could not duplicate it. But how did the poisons get into any of the yellow material, if not through chemical warfare? Several suggestions have been aired. One is that the fungus had infested bee feces and produced trichothecenes. It is known from laboratory tests that *Fusarium* fungus can feed off bee feces. Since people do not intentionally eat bee feces, how could the poisons get into the blood and urine of the alleged victims? Perhaps the alleged victims ate moldy grain? Among other things, Meselson has asked whether Mirocha could have been getting false readings in his analyses. Or whether the samples could somehow have been contaminated en route to or inside Mirocha's laboratory. None of these suggestions has led anywhere, and the mystery remains.

The government still insists, in public, that the fungal poisons found by Mirocha came from a chemical-warfare agent. In private, however, officials have been retreating. In place of the confident assertions of 1981 and 1982 that the riddle of yellow rain had been solved, officials now talk among themselves about identifying the "knowledge gaps" in their investigations. In a June, 1984, report from Fort Detrick, Sharon Watson wrote, "The most critical knowledge gap remaining in the yellow-rain investigation is the identification of the other components of the agent." She said "speculation abounds" as to what these other components may be.

Few now doubt that if the government had discovered bee droppings during its preliminary analysis, its inquiry could have taken a different and more productive course. For one thing, government analysts would have been spared the fruitless task of examining hundreds of yellow spots on leaves. For another, the inquiry could have been directed toward a more professional analysis of what the refugees were saying. Some officials concede that the yellow-rain inquiry took on a life of its own; it became impossible to tell from refugee accounts whether the attacks were increasing or decreasing. Finally, if the government's claim that harassing agents had been used was true, there could have been a serious attempt to investigate the extent of the harmful effects of the Vietnamese army's use of these supposedly non-lethal weapons.

According to some sources, American-made canisters containing CS, a non-lethal riot-control gas, which were presumably from stocks left behind in Vietnam, and Czech-made harassing-agent munitions have been found on Southeast Asian battlefields. That the very old and the very young are frequently reported among the victims of yellow rain is important evidence in this respect. Chemi-

cal-warfare experts estimate that very heavy or prolonged exposure to riot-control agents would almost certainly cause permanent lung damage and death, especially among infants, ill persons, and the aged.

But it is impossible to say if anyone died from riot-control gases. According to the published evidence, no Western doctor has examined—or even seen from a distance—a single one of the bodies of the thousands of people who were reported by the refugees to have died from chemical attacks. The charge that the Soviets used trichothecenes diverted attention from the special political problems that the United States has in condemning others' use of herbicides and, in particular, harassing agents. Whether the Geneva Protocol outlaws harassing agents and other chemical incapacitants has long been a subject of dispute, and is one that will surely be part of any discussions in Geneva about a new chemical-weapons treaty. The U.S. view has been that these agents should not be regarded as subject to the treaty's otherwise all-embracing prohibition against the use of poisonous weapons, because the United States has wanted the freedom to use them. When nations were canvassed for their views on the subject at a League of Nations Commission in 1930, Britain, Canada, China, France, and the Soviet Union took the position that all gases, including harassing agents, should be prohibited, but reserved the right to use tear gas for police purposes.

The question came up again in 1965, because the United States was using harassing gas, mostly CS, in Vietnam—for "humanitarian" purposes, the Pentagon said. Secretary of State Dean Rusk explained that its use could reduce noncombatant deaths in riot-control situations, which were the only times it would be used. This statement was later shown to be erroneous; there was no such military directive. By mid-1969 about 7,000 tons of CS had been used in Vietnam—enough to fill more than 200 million CS cartridges of the type that the British were beginning to use in Northern Ireland. United Nations Secretary General U Thant urged—not for the first time—that the Protocol be interpreted to prohibit the use of all chemical agents in warfare, but the United States and Britain continued to use them.

A 1969 government consultant's report outlining the U.S. position on incapacitants warned, "The further hazard in our employment of incapacitating chemicals in war, particularly when done on a large scale in conjunction with ordinary military operations, is that it stimulates other nations to initiate or expand their own programs for chemical (and possibly germ) weapons and erodes restraints on their use. Even if the first result is only the deployment of harassing agents on both sides in a future conflict, the introduction of weapons, defenses, and logistic arrangements all suited to chemical warfare would facilitate the progression to more powerful and deadly agents." The consultant was Matthew Meselson. □